

1. A method of epitaxially growing a second crystal over a first crystal, the first crystal having a first lattice constant, the second crystal having a second lattice constant, the method comprising the steps of:

- a) cleansing a surface of the first crystal by thermal desorption;
- b) depositing a first layer of a first material over the surface of the first crystal;
- c) depositing a second layer of a second material over the first layer; and
- d) epitaxially growing the second crystal over the second layer;

wherein the first layer substantially accommodates strain accumulated between the first crystal and the second crystal during epitaxial growth, thereby substantially preventing strain relaxation and formation of dislocation defects.

2. The method of claim 1, wherein the step a) of cleansing the surface of the first crystal by thermal desorption includes the steps of:

- a1) bringing a temperature of the first crystal to T_s °C, T_s ranging from about 495°C to about 600°C;
- a2) introducing a vapor having a vapor pressure; and
- a3) annealing the first crystal under the vapor pressure at temperature T_s ;

wherein the vapor pressure is greater than a vapor pressure of the first crystal at temperature T_s .

3. The method of claim 2, wherein the vapor pressure ranges from about 0.004 pa to about 0.012 pa, and wherein surface oxides of the first crystal are desorbed.

4. The method of claim 3, wherein the first crystal comprises group-III/group-V species, and the vapor comprises group-V species.

5. The method of claim 4, wherein the first crystal comprises GaAs, GaP, InAs or InP, and wherein the vapor comprises As_2 or As_4 if the first crystal is GaAs or InAs, or the vapor

comprises InAs, P_2 or P_4 if the first crystal is GaP or InP.

6. The method of claim 2, wherein the step b) of depositing a first layer includes the steps of:

b1) introducing into a first vapor of the first material, wherein part of the first vapor condenses on the surface of the first crystal, thereby forming the first layer; and

b2) adjusting a thickness of the first layer by varying a temperature of the first crystal;

7. The method of claim 6, wherein the first vapor is introduced at a temperature which is less than an optimal growth temperature for epitaxy.

8. The method of claim 7, wherein the first crystal comprises group-III/group-V species, and the first material comprises group-V species.

9. The method of claim 8, wherein the first crystal comprises GaAS, GaP, InAs or InP, and the first material comprises As_2 , As_4 , P_2 or P_4 .

10. The method of claim 9, wherein the thickness of the first layer ranges from approximately a few Å to approximately a few tens of Å.

11. The method of claim 10, wherein the step b1) of introducing a first vapor of the first material, includes the step of opening a first shutter blocking a growth chamber from a first vapor source.

12. The method of claim 6, wherein the step c) of depositing a second layer includes the steps of:

c1) introducing the second vapor, a temperature of the first crystal being maintained at T_d within a range of about 30°C to about 250°C, wherein at least part of the second vapor condenses over the first layer;

c2) annealing the second layer by raising the temperature of the first crystal from T_d to a

temperature of about 400°C to about 580°C, under a pressure of the first vapor of about 0.008 pa.

13. The method of claim 12, wherein an amount of the second vapor introduced is such that the second layer is formed by a mono-layer of atoms of the second material.

14. The method of claim 13, wherein the step c1) of introducing the second vapor comprises the steps of:

c11) providing a furnace containing a second vapor of the second material;

c12) opening a second shutter allowing the second vapor to travel from the furnace to a growth chamber;

wherein the second shutter is opened for a predetermined time duration, whereby to allow a predetermined amount of the second vapor to travel from the furnace to the growth chamber, the predetermined amount of the second vapor being determined by the number of atoms of the second material necessary to form a mono-layer of said atoms over first layer.

15. The method of claim 14, wherein the first crystal comprises group-III/group-V species, the first material comprises group-V species, and the second material comprises group-III species.

16. The method of claim 15, wherein the first crystal is selected from the group consisting of GaAS, GaP, InAs and InP, the first material is selected from the group consisting of As₂, As₄, P₂ and P₄, the second material is selected from the group consisting of In, Ga and Al or any combination thereof, and wherein the second vapor has a pressure of about 5×10^{-5} pa, the second vapor has a temperature of about 780° C if the second material is In, the second vapor has a temperature of about 900° C if the second material is Ga, the second vapor has a temperature of about 1200° C if the second material is Al.

17. The method of claim 16, wherein for the second material, combinations of Ga, Al, and In, are in a relative ratio substantially equal to the ratio of elements forming the second crystal which is to be epitaxially grown.

18. The method of claim 16, wherein the second shutter is opened for a time duration ranging from about 1 second to about 3 seconds.

19. The method of claim 18, wherein a number per surface area of group-III atoms forming the mono-layer is about $6.5 \times 10^{14} \text{ cm}^{-2}$ and wherein the second shutter is opened for 2.2 seconds.

20. The method of claim 16, wherein the thickness of the first layer ranges from a few Å to a few tens of Å.

21. The method of claim 12, wherein the second crystal is a group-III/group-V crystal and wherein the step d) of epitaxially growing the second crystal includes the steps of:

d1) introducing group-III species into a growth chamber;

d2) introducing group-V species into the growth chamber;

d3) maintaining a temperature inside the growth chamber near an optimal temperature for epitaxial growth of the second crystal.

22. The method of claim 21, wherein the group-V species is introduced by opening a first shutter whereby to let a group-V flux into the growth chamber, and the group-III species is introduced by opening a second shutter whereby to let a group-III flux into the growth chamber.

23. The method of claim 22, wherein the ratio of the group-V flux to the group-III flux is substantially in the range of about 1.5 to about 3.

24. The method of claim 23, wherein the second crystal is selected from the group consisting of InAs, $In_xGa_{1-x}As$, $In_xAl_{1-x}As$ or GaP.

25. The method of claim 1, wherein the method is used to manufacture semiconductor devices.

26. The method of claim 25, wherein the method is used in microelectronic and optoelectronic applications.

27. (Amended) A method of preparing a substrate for subsequent epitaxial growth of a crystal over the substrate, the method comprising the steps of:

- a) cleansing a surface of the substrate by thermal desorption;
- b) depositing a first layer of a first material over the surface of the substrate; and
- c) depositing a second layer of a second material over the first layer, wherein the crystal is deposited over the second layer.

28. The method of claim 27 wherein the first layer accommodates strain accumulated between the substrate and the crystal during epitaxial growth, thereby preventing strain relaxation and formation of dislocation defects.

29. The method of claim 28 wherein:

- the substrate comprises group-III/group-V species;
- the crystal comprises group-III/group-V species;
- the first material comprises group-V species; and
- the second material comprises group-III species.

30. The method of claim 29, wherein the first layer has a thickness within a range of approximately a few Å to a few tens of Å.

31. The method of claim 30, wherein the second layer is a monolayer of group-III atoms.

32. A method of preparing a GaAs substrate for subsequent epitaxial growth of a InAs layer over the substrate, the method comprising the steps of:

- a) extracting surface oxides from a surface of the substrate by thermal desorption, the thermal desorption including the steps of:
 - a1) heating the substrate to a temperature of about 600°C; and
 - a2) annealing the substrate for about 10 minutes under a pressure of As₂ vapor of about 0.008 pa;
- b) depositing a condensed layer of As₂ on the surface of the substrate, depositing a condensed layer including the steps of:
 - b1) lowering the temperature of the substrate to about 110°C while subjecting the substrate to an As₂ vapor pressure of about 0.008 pa, whereby a condensed layer of As₂ is formed on the surface of the substrate; and
 - b2) adjusting the thickness of the condensed layer of As₂ by raising the temperature of the substrate to about 250°C, thereby thinning the condensed layer of As₂ to several tens of Å; and
- c) depositing a mono-layer of In atoms over the condensed layer of As₂, the depositing a mono-layer comprising the steps of:
 - c1) introducing In vapor at a temperature of about 790°C, the temperature of the substrate being maintained around 250°C and being subjected to an As₂ vapor pressure of about 0.008 pa; and
 - c2) raising the temperature of the substrate to about 400°C while the As₂ vapor pressure is maintained around 0.008 pa, thereby annealing the mono-layer; wherein upon completion of the step c), conditions are propitious for epitaxial growth of the

InAs layer, and wherein the epitaxial growth substantially does not introduce dislocation defects caused by lattice mismatch between the GaAs substrate and the InAs layer.

33. The method of claim 32, further comprising the step d) of epitaxially growing the InAs layer, the step d) including the steps of:

d1) introducing a flux of In vapor;

d2) introducing a flux As vapor; and

d3) maintaining the temperature of the substrate between about 400°C and about 450°C; wherein the ratio of the flux of As vapor to the flux of In vapor is maintained at about 2.5.

39. (New) The method of claim 1, wherein the first crystal comprises the first material of the first layer and the second crystal comprises the second material of the second layer, and wherein the first material is a group-V species and the second material is a group-III species.

40. (New) The method of claim 27, wherein the first crystal comprises the first material of the first layer and the crystal comprises the second material of the second layer, and wherein the first material is a group-V species and the second material is a group-III species.